Two-parameter data-acquisition system for slit-scan chromosome analysis

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BRIEF DIGITAL NOTES

Brief Digital Notes are extended abstracts (approximately 300 words) indicating succinctly the significant features of a useful application of digital technology and instrumentation; details of hardware or software are omitted but should be available on request from the author. See editorial in Vol. 54, No. 4, 1984; more details can be obtained from the Editor.

Two-parameter data-acquisition system for slit-scan chromosome analysis

We describe a data-acquisition system, which is able to record two-parameter fluorescence or light scatter signals from a flow cytometer coincidently at very high rates. This was achieved by interfacing a homemade waveform digitizer to a minicomputer. Using minimal laser focus dimensions the system is routinely used for high-resolution slit-scan chromosome analysis.

Some years ago, when the prices for fast analog-to-digital converters were still extremely high, it was advised to store fast photomultiplier signals in analog memories and perform the conversion at moderate speed. Multiparameter signal analysis was done using multiplexed analog systems with only one high-speed converter. Switching between two input signals slows down the individual digitization rate. If one input signal is delayed for a sufficient time and both signals are sampled consecutively, the maximum temporal resolution is retained, but the simultaneity is lost.[1] As a consequence of increasing production quantities of video digitizers, high-speed analog-to-digital converters are offered at low prices. So-called "flash" converters, where no additional sample-and-hold circuitry is necessary, allow an easy design of transient digitizers. We developed a waveform recorder based on RCS's CA 3300 6-bit flash converter and the 64 words by 9-bit rams 82S19 (Valvo). For each channel two converters were cascaded to deliver 7-bit + overflow bit resolution. The estimated cost for parts for the two-channel recorder including cabinet, power supply, and computer interface is less than US $2000.

The instrument has the following features: (i) the digitization rate may be selected between 0.3 and 20 megasamples/s, (ii) the internal high-speed memory latches 64 bytes of 8-bit data per channel, (iii) the digitization of both input channels and storage of data are performed coincidently, (iv) a parallel interface using high-speed optocouplers allows fast data transfer to the computer.

Although there is no limitation in interfacing any mini- or microcomputer, we use a DATA GENERAL (DG) ECLIPSE S/140 for maximum performance.

A program library "SCAN" contains a number of different data-acquisition (single and dual parameter) and data-evaluation programs. Program parts for input/output operations, the interrupt handler and data-acquisition programs are written in assembly language. Routines for calculations and display of results were programmed using DATA GENERAL's FORTRAN 5 compiler.

During data-acquisition histograms of various parameters of the input signal may be generated and displayed in real time. More complex calculations as well as data reduction procedures are carried out next to the data acquisition.

The system is able to handle up to 400 signals/s when the data transfer to the computer is initiated by an interrupt request. By means of a DG general purpose interface board with direct memory access (DMA) signals rates of up to some 10 000/s may be processed.

To test the preamplifiers and analog-to-digital converters as well as new software, a test generator is integrated. It delivers signals with a pulse shape having different numbers of local maxima.[2]

Due to its modular composition the transient digitizer may easily be adapted to different applications, when a great number of high-speed signals/s have to be recorded. By a number of minor changes it may be expanded to digitize an enhanced number of input channels. The adaption of the software to different computers will turn out to be easy, if a FORTRAN compiler is available.

Hardware documentation of the transient digitizer and the interface to the DG computer, as well as program listings can be obtained from the authors.

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